Forest-Structure Analysis in the Paraguayan Chaco, combining Sentinel and GEDI data

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Abstract
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Abstract

Tropical forest ecosystems have been identified as one of the most diverse regions in the world. Offering extensive ecosystem services such as climate regulation and rich biodiversity has raised increasing concerns about their future and protection. Latest studies conducted at a global scale have defined Argentina, Brazil, and Paraguay as the countries with the highest rates of deforestation in South America. With an area of about 250 000 km², the Paraguayan Chaco covers about one fourth of the Great American Chaco which spreads out over Argentina, Bolivia and Paraguay. The Paraguayan Chaco comprises not only a great variety of ecosystems such as savannahs, shrublands, grasslands and wetlands but also holds the largest dry forest area on earth. Furthermore, the ecoregion has been acknowledged as an important carbon sink on a global scale. Nevertheless, uninterrupted deforestation activities between 1987 and 2012 resulted in the loss of 27 % of its original cover. The constant expansion of agricultural crops, cattle ranching, and illegal logging have severely fragmented the Paraguayan Chaco transforming the last forest remnants into isolated patches, jeopardizing not only their continuity but also the biodiversity comprised within. In this context, this study focuses on the assessment of the annual forest cover between 2016 and 2020 using Sentinel-1 and -2 on the one hand and estimating forest structure parameters with data from the Global Ecosystem Dynamics Investigation (GEDI) on the other. Annual forest / non-forest masks generated through machine learning algorithms show a continuous annual decrease of the forest cover. Between the years 2016 and 2020 9 % of the natural forest cover was lost, resulting in 12 500 km² (Figure 1a)). Regarding forest structure, more than 7.2 million valid lidar shots have been analysed to determine forest height, vertical Plant-Area-Volume-Density, Foliage-Height-Diversity-Index (FHDI) and Plant-Area-Index (PAI). Preliminary results exhibit that more than 55 % of the forest height is between 3 to 9 meters (Figure 1b)) and heights greater than 15 meters are mainly located in the North-East of the Paraguayan Chaco. Additionally, vegetation density appears to be rather sparse which is described by mean values of total canopy cover (17 %) and PAI (0.44 m²/m²). On the other hand, highest vegetation densities and closed forest canopies are observed in the North and North-East (Chaco Biosphere Reserve) where most of the protected areas and indigenous reserves are located. Overall continuous expansion of the agricultural frontier, illegal logging activities, and the constant demand for natural goods threaten the continuity of the tropical forest. To meet these challenges, there is an urgent need to develop methods and approaches in the field of remote sensing observations. This would simplify the implementation of environmental laws and conservation programs orientated toward protecting the last remnants of natural forest on the continent. Countries with large, forested areas such as Paraguay should be taking advantage of the latest natural resources available to halt and monitor deforestation activities in the country. With upcoming data from GEDI and fusion products of optical and lidar sensors, global forest structure data will improve estimates of above-ground biomass models to better quantify global carbon fluxes, further highlight drastic losses of forests and promote environmental-sound land use.

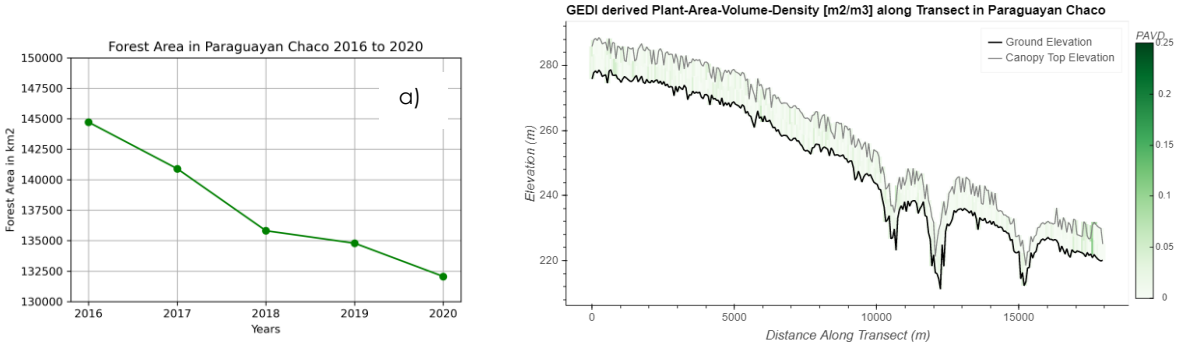

Figure 1. (a) Annual Forest Area from 2016 to 2020 (b) PAVD along Forest Transect